

学校编码: 10384

分类号__ 密级

学 号: 22420081153684

UDC



硕 士 学 位 论 文

海湾地区非点源污染管理方法对比研究

——以切斯皮克湾和厦门湾为例

COMPARATIVE STUDY ON APPROACH FOR NONPOINT SOURCE POLLUTION
MANAGEMENT IN TWO COASTAL BAYS—TAKING CHESAPEAKE BAY AND
XIAMEN BAY AS EXAMPLES

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论文提交日期: 2010 年 5 月

论文答辩时间: 2010 年 6 月

学位授予日期: 2010 年 6 月

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2010 年 6 月

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Dedication

This thesis is dedicated to Almighty God, my parents, my brothers and Sisters; late Basomingera Alfred and his parents, Kalimba for their encouragement, support and prayers.

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Abstract in Chinese

海岸带（包括沿海港湾）地区处于陆海交界地带，是人类活动密集区。全世界大约有60%的人口居住在海岸带地区人类活动（包括城市化过程、围海造地等）是影响海岸带形态和生态系统的主要驱动力，因此该区域也是典型的生态脆弱带。在过去的几十年里，世界各地海岸带地区的水质都有显著的下降，而非点源污染是水质退化的重要原因。因此研究港湾地区的非点源污染的管理具有重要的意义。

本研究搜集了切萨皮克湾（Chesapeake Bay, CPB）和厦门湾（Xiamen Bay, XMB）的相关文献和数据进行二者在非点源污染管理方面的比较研究。CPB 是北美最大的海湾，存在着营养盐过剩、水体富营养化等水质问题。XMB 地处中国经济高速发展的经济区，水质近年来持续下降。本研究开展了切萨皮克湾和厦门湾非点源污染管理方法的对比研究。研究内容包括：对比分析沿海港湾的非点源环境治理（包括监测管理机构）、研究方法（地理信息系统和建模方法）以及管理措施（最佳管理措施（BMPs））。得到的主要结论如下：

（1）在 CPB，美国环保局，美国农业部和各州在非点源污染的治理中都发挥了重要的作用。在 XMB，ICM 项目组和政府组织（如九龙江流域管理委员会）也在污染的治理过程中发挥着积极的作用，但是来自上游地区的非点源污染物的治理问题仍然是一个巨大的挑战。

（2）GIS 与模型是定量非点源污染来源构成与空间表达污染关键源区的重要方法，这在 CPB 和 XMB 都具有共性。在 CPB，基于 GIS 的 SPARROW 和 WSM 模型被用于海湾非点源污染源的定量估算、模拟分析与空间表达。在 XMB，基于 GIS 的 AGNPS、AnnAGNPS 和经验模型（USLE 等）也会应用于流域与港湾的非点源污染的通量估算与关键源区识别。模型与监测的良好结合对于两个港湾都是一个挑战，尤其在厦门湾，需要进行流域与港湾水质监测网络的完善，以应对由于数据稀缺造成模型应用受限的情况。

(3) 在两海湾的治理过程中都采用了有一些略微差异的最佳管理措施 (BMPs)。CPB 与 XMB 都关注于如何能够让更多的上游地区的当地农民参与进来减少污染, CPB 的 BMPs 应用更为广泛, 更为具体与可具可操作性, XMB 的 BMPs 目前尚在尝试之中。

作者希望本研究可增进政府官员、利益相关者等对相似港湾区域非点源污染环境治理的认识和理解, 并共同致力于沿海非点源污染的监测与管理。

关键词: 港湾地区;非点源污染管理;BMPs; GIS;模型.

Abstract

Coastal areas, including gulf regions, are interaction areas between the land and the ocean, suffer from intense human activity, Over 60% of the world's population lives within the coastal zone (e.g. urbanization), and so they become ecologically vulnerable. Human activities, including urbanization processes, are major driving forces that greatly modify the shape of a coastal area and its ecological environment. During the last few decades, a significant decrease of water quality has been observed in different coastal areas of the world, it has been attributed to an increased contribution of Nonpoint Sources Pollution (NPS). Therefore, Nonpoint Source Pollution management is of great significance.

We collected the literatures and data about Chesapeake Bay (CPB) and Xiamen Bay (XMB) to compare the technologies and managements applied in them. Chesapeake Bay is the largest estuary of the U S A and has been adversely affected by nutrient enrichment. Excessive nutrients have caused eutrophication; contributing to periods of hypoxia and poor water-clarity conditions that deprives living resources of necessary oxygen and sunlight. On the other hand, the fact that Xiamen city is Economic Zone has speeded up the urbanization and industrialization of the region during the past 28 years. It has also brought a serious environmental problem to Xiamen Bay.

This study conducted a comparative study on approaches for NPS Pollution Management in XMB and CPB in terms of environmental governance, GIS and modeling methods, and Best Management Practices (BMPs).

The main conclusions are as follows:

- (1)U.S. Environmental Protection Agency, U.S. Department of Agriculture and States around CPB have played important roles in controlling Chesapeake Bay NPS pollution. In XMB, ICM project team and government organizations (e.g., Jiulong River Watershed Management Committee) also plays an active role in pollution control process, but the environmental governance issue of NPS Pollution from the upstream region remains a great challenge.
- (2)GIS and model are important methods for quantification and visualization of NPS Pollution, which are common to CPB and XMB. In the CPB, GIS-based model SPARROW and WSM

were used to quantitative estimate of the source of NPS pollution, simulation analysis and spatial expression. In XMB, AGNPS, AnnAGNPS and empirical model based on GIS were also applied to quantify NPS loads and identify critical source areas of NPS pollution. Modeling and monitoring have not been well integrated in NPS pollution management in both Bays. Especially, water quality monitoring network in XMB should be improved due to the fact that sparse data to great extent limited the application of the models in NPS management.

(3)CPB and the XMB are both focused on how to encourage more local farmers in upstream involvement to reduce pollution. However, there is no wide range for BMP implemented in Xiamen bay. Comparatively, practices in various aspects are implemented among Chesapeake watersheds and site specific areas.

The author hopes that this study can deepen our understanding on current situation of NPS Pollution management in coastal bays. The lesson captured from the study is supposed to help Government, coastal dwellers and all stakeholders develop the awareness on NPS pollution management in both Bays. The approach comparison will make policy makers, partnerships and nonprofit organizations learn more from one another by adopting the same techniques or system to tackle with the same problem, to promote NPS pollution management.

Key Words: Nonpoint source; Coastal Bay; Environmental governance; Best Management Practices; GIS; Models

Acronyms

AMA: Agriculture Management Assistance

AMD: Abandoned in Mine Drainage

AnnAGNPS: Annualized Agricultural Nonpoint Source Pollution

ANSWERS: Areal Nonpoint Source Watershed Environment Response Simulation

ARM-HSPF: Agricultural Runoff Model - Hydrological Simulation Program - FORTRAN

BASINS: Better Assessment Science Integrating Point and Nonpoint Sources

BMPs: Best Practice Management

BNR: Biological Nutrient Removal

BOD: Biological Oxygen Demand

CAP: Common Agricultural Policy

CBIG: Chesapeake Bay Implantation Grants

CBSF: Clean Bohai Sea Program

CCFP: Conversion of Cropland into Forestland Program

CELCP: Coastal and Research Estuarine Land Conservation Program

CNPCP: Coastal Nonpoint Pollution Control Program

COD: Chemical Oxygen Demand

CPB: Chesapeake Bay

CPBWFP: Chesapeake Bay Washington Fine Properties

CREAMS: Chemicals, Runoff, and Erosion from Agricultural Management Systems

CREP: Conservation Reserve Enhancement Program

CRP: Conservation Reserve Program

CSP: Conservation Security Program

CTA: Conservation Technical Assistance

CTP: Conservation Tillage Practice

CWA: Clean Water Act

CWSRF: Clean Water State Revolving Fund

CZARA: Coastal Zone Act Reauthorization Amendments

CZM: Coastal Zone Management

CZMA: Coastal Zone Management Act

DPSIR: Driving Forces, Pressure, State, Impacts, and Responses

EPA: Environmental Protection Agency

EQIP: Environmental Quality Incentive Program

ESA: Ecological Society of America

ESRI: Environmental Science Research Institute

FRPP: Farm and Ranch Lands Program

FSA: Farm Service Agency

GIS: Geographic Information System

GLEAMS: Groundwater Loading Effects of Agricultural Management Systems Model

GPS: Global Positioning System

GRP: Grassland Reserve Program

GVFS: Grass vegetated filter strips

HNO₃: Nitrate Hydrogen

ICM: Integrated Coastal management

IRF: Irrigation Return Flow

IWMM: Integrated Watershed Management Model

JRW: Jiulong River Watershed

MDNR: Maryland Department of Natural Resources

MEQTM: Marine Environmental Quality Tendency Monitoring

MFZM: Marine Functional Zones Monitoring

MPA: Marine Program Agency

MWCOG: Metropolitan Washington Council of Governments

NERRS: National Estuarine Research Reserve System

NFWF: National Fish and Wild Life Foundation

NH₄: Ammonium

NOAA: National Oceanic and Atmospheric Administration

NPS: Non Point Source

NPSIG: New Professionals Special Interest Group

NRCS: Natural Resources Conservation Service

OCPs: Organochlorine Pesticides

OECD: Research of the Organization for Economic Co-Operation and Development

PEMSEA: Partnerships in Environmental Management for the Seas of East Asia
 PLOAD: Pollutant Load Application
 PS: Point Source
 RFBS: Riparian Forest Buffers System
 RMB: Renminbi
 ROG: Regional Ocean Governance
 RUSLE: Revised Universal Soil Loss Equation
 SAV: Submerged Aquatic Vegetation
 SCS: Soil Conservation Service
 SCS-CN: Soil Conservation Service-Curve Number
 SEPA: State Environmental Protection Administration
 SMPTWQ: Supervision Monitoring Program for Trend of Water Quality
 SPARROW: Spatially Referenced Regressions on Watershed Attributes
 STJ-EROS: St. John Erosion Model
 SWAT: Soil and Water Assessment Tool
 SWCS: Soil and Water Conservation Society
 TGRA: River Watershed in Three Georges Reservoir Area
 TMDLs: Total Maximum Daily Loadings
 TWG: Targeted Watershed Grants Program
 U.S.: United States
 USACE: United State Army Corps of Engineering
 USAFWS: United States Air Force Weapons School.
 USDA: United States Agriculture Department
 USDTFHA: U.S. Department of Transportation, Federal highway administration
 USEPA: United States Environmental Protection Agency
 USGS: United State Geological Survey
 USLE: Universal Soil Loss Equation
 VDEQ: Virginia Department of Environmental Quality
 WATFLOOD Model: flood forecast hydrological model
 WHIP: Wildlife Habitat Incentives Program
 WRP: Wetlands Reserve Program
 XMB: Xiamen Bay

Chapter 1 : General Introduction

1.1 Introduction

From ancient times, people have chosen to live near water, settling in river valleys, beside lakes, or along coastlines. The attractions of water are as diverse as human needs and aspirations. Clean water is a crucial resource for drinking, irrigation, industry, transportation, recreation, fishing, hunting, support of biodiversity, and sheer esthetic enjoyment (Carpenter et al., 1998). Over 60% people live within coastal zone where they enjoy a close relationship with the nature and culture intermixing as well (Bartlett and Smith, 2005).

Nonetheless, Continued growth of world population and pollution from human activities in coastal areas have been stressing coastal and entire marine environment (EPA, 1994). Huge coastal area population increased environmental pressure; land use, urbanization, pollution resulted in a series of Point and Nonpoint Source Pollution problems (Li and Dag, 2004).

It is well documented that NPS pollution plays an important role on water quality degradation in coastal areas. Agricultural NPS pollution has been proved as one of the main sources of pollutions in many costal states. For example, agriculture causes 60% of the total nitrogen emissions and 40%-50% of the total P emissions to surface waters in the Netherlands, 81% for nitrogen and to 93% for phosphorus in china and in USA, more than 60% of surface water pollution are caused by agricultural NPS pollution (Wang., et al., 2005; Edwin et al., 2010).

Chesapeake Bay watershed program model estimates that 39% of the phosphorus and 67% of Nitrogen delivered to the bay system come from NPS pollution (Chesapeake Bay Executive council, 1985; Karuppiah and Giangupta, 1996). In Chesapeake Bay basin agriculture commercial fertilizers are specifically identified as the primary NPS of nitrogen and phosphorus, contributing about 40% of the total nutrient load (Mander and Forsberg ,2000).While NPS pollution in Xiamen bay is said to be from the large amount of fertilizer enters the runoff, which mainly happens in summer with heavy rain falls. In addition, water soil loss and the use of pesticides also make the NPS pollution serious (Xue et al., 2004). Huang et al., (2010) found that NPS pollution were the main source for COD_{MN} in all XMB sub-sea areas, and occupied over

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